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ABSTRACT

This paper reviews two of the United Kingdom's national programs to promote the use of computer-based teaching throughout higher education. In the first phase (1985-89) of the Computers in Teaching Initiative (CTI), a suite of 139 individual software-production projects generally failed to meet expectations. In 1989, CTI became a network of subject-based centers with a remit to promote the use of information technology (IT) within specific academic disciplines. Following wholesale changes in the national organization of higher education in 1991, the UK government sought to double the number of students in higher education. A new program of courseware development was initiated, the Teaching and Learning Technology Programme (TLTP): 75 projects are currently being funded, involving both single academic institutions and consortia. One example of TLTP project, Geography-CAL, which aims at specifying, developing, testing, and delivering a library of 21 high-quality transportable computer-based learning (CBL) modules and other support material, is described in detail. In examining the effects of these initiatives, it is concluded that, while CBL has pedagogical benefits, there are many factors which hinder its adoption by university teachers. (Author/MAS)

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The Development of Computer Assisted Learning in UK Universities

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Abstract: The paper reviews two of the UK's national programmes to promote the use of computer-based teaching throughout higher education. In the first phase (1985-9) of the Computers in Teaching Initiative (CTI), a suite of 139 individual software-production projects generally failed to meet expectations. In 1989 CTI became a network of subject-based centres with a remit to promote the use of information technology (IT) within specific academic disciplines. Following wholesale changes in the national organisation of higher education in 1991, the UK government sought to double the number of students in higher education. A new programme of courseware development was initiated, the Teaching and Learning Technology Programme (TLTP): 75 projects are currently being funded, involving both single academic institutions and consortia. In examining the effects of these initiatives it is concluded that, while computer-based learning (CBL) has pedagogical benefits, there are many factors which hinder its adoption by university teachers.

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The development of innovative teaching and learning materials in higher education within the UK invariably assumes an increased role for information technology (IT). The Computers in Teaching Initiative (CTI) and the Teaching and Learning Technology Programme (TLTP) have national remits to promote the use of IT in university teaching. This paper reviews the progress of the three distinct approaches that have been followed:

(1) CTI Phase I: largely concerned with software production;
(2) CTI Phase II: subject-based centres within academic disciplines; and
(3) TLTP

(1) The Computers in Teaching Initiative. Phase one: 1985-1989

It was generally accepted throughout the 1970s that computers were being under-used in teaching in UK universities. As a result central funds were earmarked to provide more computing resources for use by undergraduates, typically hardware in the form of multi-access minicomputers. In the bidding process which followed science and engineering were particularly favoured. However, the rapid introduction of microcomputers in the 1980s changed the nature of academic requirements somewhat, as did the realisation that very little effort was being focused on utilising the general educational potential of computers for teaching. Although computer-based learning (CBL) was beginning to emerge, very little suitable software was developed.

Overall responsibility for computers within higher education in the UK was vested in the Computer Board for Universities and Research Councils (CBURC) which immediately saw the need to develop not only software but also support materials for teaching purposes. Through a new initiative, CTI, funds were made available to develop and produce the resources needed throughout higher education. CTI's main aim was to promote computer-based learning and trainin~ This would involve (a) assessing the pedagogical potential of IT; (b) promoting increased awareness of the potential benefits of IT for university teachers, students and administrators; (c) assessing needs throughout higher education; and (d) producing and implementing educational software. Clearly the focus had shifted from hardware to software. Organisational and logistical issues were also considered important issues, as were techniques and standards for evaluating software. Funds were disbursed through a competitive bidding process. Although the overt objective was to provide for more software development, the underlying ethos was concerned with influencing the ways in which students were taught and engendering a more receptive environment for CBL. By 1987 some 139 projects had been approved from a total of 700 bids received and at least one project was awarded in each university (Table 1). Most projects were centred within individual university departments with a focus on undergraduate teaching. A total of £9.5m was

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made available centrally, with possibly double that amount being contributed by the universities in terms of staff time, space and facilities, and other resources.

Despite high expectations that the projects' software products would be widely disseminated throughout tertiary education some major difficulties quickly emerged. No attempt was made to standardise hardware platforms and about half of the software was developed on equipment that rapidly became obsolete. There were also other impediments to the intended widespread take-up and portability of the materials throughout disciplines; materials developed in one department were often considered "inappropriate" elsewhere, a phenomenon which became known as the "*not-invented here*" syndrome. With very few exceptions, most of the software products were used solely within the departments in which they were developed. Although the poor level of inter-departmental portability was obviously very disappointing, there were some successes and much was learned from the exercise. Reports on CTI Phase one were produced by Gardner (1988) and Gershuny and Slater (1989).

Table 1

Distribution, by main academic discipline, of projects and funds in CTI Phase 1 (from Gershuny and Slater, 1989)

Academic Discipline	**Number of Projects**	**Mean Funds per Project**
		UK £ 000s
Mathematics/Statistics	12	74
Computing/Logic	30	73
Engineering	8	58
Physical Sciences	9	71
Medicine/Biology	14	47
Agriculture/Geography/Geology	12	60
Social Sciences/Humanities	13	49
Law/Business Studies	13	42
Ancient/Modern Languages	9	42
Other Combinations	19	27
ALL DISCIPLINES	**139**	**TOTAL FUNDING £9.5m**

(2) CTI Phase 2, 1989-93: Subject-based Centres

The second phase of the initiative was intended to consolidate the successful aspects of the first phase and address areas that required further attention. A more solid infrastructure was to be secured within subject-specific academic domains by providing human support for CBL rather than more software. Competitive bids were again invited and funding was provided to establish 21 subject-based centres throughout the university sector. The subjects covered some 95% of undergraduate teaching areas and a coordinating body, the CTI Support Service (CTISS), was also established. Each centre had the task of promoting the use of CBL in teaching within its individual academic constituency, but was not permitted to undertake software development. Following minor adjustments the initiative now incorporates CTISS and the 20 centres shown in Table 2.

Average annual running costs of each centre are about £40,000 and host institutions also contribute facilities and additional support. Typical staffing comprises a director, coordinator and secretary. Total funding for the second phase has been of the order of about £1m annually, considerably less than for CTI Phase one.

Although the centres' activities vary according to the nature and needs of their disciplines, they all perform an essential core. These include dissemination via print and electronic media of information about good practice in CBL, reviews of software, conferences, workshops and seminars, visits to departments, academic papers, and an advisory service, all available *gratis* throughout the UK university network.

Collectively the centres have been very productive. In the academic year 1992/3, the centres produced 18 subject-based courseware/resource guides averaging 156 pages each. Some 66 Journals and Newsletters were published, and over 6,000 screens of information were posted on academic bulletin-boards maintained by NISS (National Information on Software and Services) and other agencies; 225 software products were reviewed; 23 electronic mail discussion/information lists were set up; 246 departmental visits were conducted, and over 30,500 individual enquiries were dealt with (CTISS, 1994, 5-7).

CTI's second phase has generally been regarded as very successful, bearing in mind the original terms of reference. The centres have been very active and productive, but it has to be recognised that they were never resourced sufficiently to bring about a widespread *cultural* change in the way university teaching was carried out. The human element which the CTI Centres have provided has proved an indispensable form of support without which CBL would remain isolated and perhaps solely the preserve of technology enthusiasts. The need to provide and implement support mechanisms of this type has been widely acknowledged at many levels of the university community, particularly at the "grass roots" department level, and an external audit by French *et al* (1991) commended the centres on both their performance and cost-effectiveness. General reports on the CTI have been produced by Darby (1991; 1992), and Robinson (1992) has reviewed progress within one of the centres.

Table 2
The discipline-based infrastructure of CTI Phase 2

Subject Centre	***Host University***	**Subject Centre**	***Host University***
Accountancy, Finance & Management)	*East Anglia*	Law	*Warwick*
Biology	*Liverpool*	Library & Information Studies	*Loughborough*
Chemistry	*Liverpool*	Mathematics & Statistics	*Birmingham & Glasgow*
Computing	*Ulster*	Medicine	*Bristol*
Economics	*Bristol*	Modern Languages (with Classics)	*Hull*
Engineering	*London (QMWC)*	Music	*Lancaster*
Geography, Geology, Meteorology & Planning	*Leicester*	Physics	*Surrey*
History	*Glasgow*	Psychology	*York*
Human Services	*Southampton*	Sociology, Politics & the Policy Sciences	*Stirling*
Land Use Studies	*Aberdeen*	Textual Studies	*Oxford & Bath*

The CTI model for promoting the use of IT in teaching and learning has attracted great interest in other countries, although little of this interest has yet been translated into action. Through its Council for Renewal of Undergraduate Education, the Swedish government has recently funded a discipline-based initiative based on the UK CTI model. Exchange visits between UK and Swedish CTI staff took place in 1992 and 1993, and a report on this cooperative venture was published recently (Martin, Darby and Kjölleström, 1994). The Republic of Ireland has also recently established a similar organisation. Some 200 academic institutions subscribe to CTI services, and there are many examples of individual CTI Centres having developed informal international associations.

By providing infrastructural support, evaluating courseware and identifying and propagating good practice in its adoption, the CTI Centres have continued their role of enabling a more rapid and comprehensive penetration of CBL into the mainstream of university teaching and learning. However, it was recognised that for fundamental change to occur, CBL had to be integrated into the teaching curriculum on a widespread basis.

The Context of Current Courseware Development

A continued lack of suitable courseware within academic disciplines remained the most pressing need. As a result the CTI recommended that a second programme of courseware development be instituted (Darby, 1991). This recommendation was accepted, but the academic context was radically revised following a major restructuring of organisation of higher education which took place in 1993.

Prior to 1993 the higher education community comprised (a) universities which could award degrees in their own right; (b) polytechnics, which were somewhat more vocationally orientated and whose degrees were validated by the UK Council for National Academic Awards; and (c) other tertiary colleges and institutes. Universities were funded by the Universities Funding Council (UFC) and other institutions were funded by the Polytechnics and Colleges Funding Council (PCFC). On 1 April 1993 the so-called "*binary-divide*" between universities and polytechnics was removed, thereby allowing polytechnics to assume full university status. Thus the number of universities increased from 48 to 115. The UFC and PCFC were replaced by four bodies: separate Higher Education Funding Councils (HEFCs) for each of England, Scotland and Wales, with the Department of Education for Northern Ireland taking responsibility for higher education in that province.

In advance of this major reorganisation the UK government in 1991 initiated policies to increase access to higher education and to double the number of students by the year 2000. However, this was to be brought about *without* a commensurate increase in university resources, which effectively remained static. As a result information technology was perceived by some senior figures in higher education as a means of delivering cost-effective education for increased numbers of students.

(3) The Teaching and Learning Technology Programme

In the 1980s, courseware had been developed piecemeal and the absence of a national strategy for its development and lack of generally-accepted standards made it difficult to integrate such material into existing courses. There was a clear need for courseware that conformed to acceptable standards of design, flexibility, delivery and pedagogy. It was recognised that courseware of this kind is most likely to be produced by nationally-funded consortia of academics collaborating across institutional or departmental boundaries. This strategy was embodied within TLTP which was announced in April 1992. It had a budget of £15m, and would run for a three year period beginning September 1992.

Its objectives were similar to those of the first phase of CTI in that it would support a series of projects each producing courseware for teaching in a variety of disciplines. Bids were invited from both subject-based and institutional consortia as well as individual institutions who could show that materials they produced would be widely adopted (UFC, 1992). In the first phase some 42 projects were approved, bids for 12 of which were coordinated by CTI Centres. The majority of the other 30 were institutional bids. Polytechnics were excluded from participating in the first year because they were not, at that time, funded through UFC: they were allowed to join in the programme in subsequent years however, following removal of the binary divide.

The projects had a wide geographical and disciplinary spread although bids from the natural sciences and engineering outnumbered those from the humanities and social science. The overall character of TLTP projects is also reminiscent of the first phase of CTI. The focus on consortia was intended to minimise the adverse effects of a tradition of local autonomy in curriculum design and delivery which might, despite strong financial control by the central funding body, frustrate the intentions of the initiative that collaboration within disciplines should lead to widespread adoption of the courseware that is developed.

In April 1993 the HEFCs for England, Wales, Scotland and Northern Ireland jointly invited more bids for a second round of TLTP projects with the explicit aim of making teaching and learning more productive and efficient by harnessing modern technology. By the 4 July 1993 deadline 384 bids, for a total of almost £50m had been submitted . Of these, 33 projects were funded, and £3m was committed for the first of three years. In this second phase two CTI Centres, History and Geography, were successful in securing funds: both of them head large consortia of departments within their respective academic communities. As with the first phase of TLTP, the overall aim was to fund the development of transportable, cost-efficient, quality teaching and learning resources which, *inter alia*, facilitate flexible learning strategies, improve course delivery, and make better use of staff time. Productivity gains had to be quantified and attention paid to the issue of common standards of authoring environments. The expectation at the time that the new universities (former polytechnics) would be particularly favoured (as they had been excluded in phase I) proved unfounded. Similarly, an expectation that priority would be given to projects which integrated access to centralised resources, such as data archives and information services, was not matched by the actual allocation of funds. Again science and technology were favoured.

An example of a TLTP project

Finally, by way of illustration, we provide details of the TLTP project with which, as Co-Director and Coordinator, we are closely involved. The project was one of the 33 successful bids under phase II of the TLTP, and commenced in September 1993. It is jointly led by the CTI Centre for Geography and the Division of Geography at Coventry University and involves a consortium of 75 university departments of geography throughout the UK. Resources secured amount to approximately half a million pounds sterling over a three-year period.

The aims of the project, named Geography-CAL, are to specify, develop, test and deliver a library of 21 high-quality transportable CBL modules and other support material intended to facilitate an efficient and effective teaching and learning environment for core topics, concepts and techniques in introductory undergraduate geography courses. Geography, as one of the broadest academic disciplines, draws on material from the natural, physical and earth sciences, the social sciences and the humanities in examining the relationships between people and their environment. Emphasis on analyzing the spatial and temporal patterns of phenomena has meant that graphical skills are fundamental requirements for all its students. Computers are an ideal medium for graphical representation, data analysis and simulation in teaching geography.

The project comprises three main stages: (i) an assessment of academic needs and a review of existing courseware; (ii) development and testing of courseware modules; (iii) an evaluation of the effectiveness and use of modules in the consortium's member institutions. An effective learning environment involves (a) selecting topics, concepts and techniques in which presentation of material by computer is superior to conventional methods of delivery; (b) adopting an interactive problem-orientated approach to learning, which will help develop students' enthusiasm and involvement; (c) developing quality, user-friendly courseware which combines multimedia elements of text, graphics, images, animations, simulations; and (d) formative assessment exercises.

Academic expert panels for each of the modules provide a detailed specification which is then passed to a team of three programmers who will produce the module using authoring software. Because IBM-compatible PCs running under Microsoft Windows represents the most common hardware platform in UK geography departments, Asymetrix' *Toolbook* was selected as the most suitable authoring system.

We envisage that acceptability of the material to university teachers will be enhanced by (a) actively involving potential users in the selection of topics, concepts and techniques and in the development, testing and evaluation of the CAL modules: a programme of workshops for consortium members is being organised from an early stage of the project; (b) circulating a regular newsletter reporting progress on the project; (c) designing each courseware unit around a discrete topic, concept or technique, so as to lend itself to being used independently or in connection with other units; (d) including automated assessment procedures; (e) producing flexible teaching materials suitable for first-year students who have not previously studied geography, whilst allowing those with some previous study of the subject to investigate topics in greater depth; (f) ensuring transportability of courseware by using a common authoring standard; (g) enabling teachers to customise the software to reflect local needs and interests; and (h) providing a staff training and support programme to help potential users to integrate the courseware into their teaching.

Together these mechanisms should increase the feeling of "ownership" of the courseware by potential users and encourage its widespread adoption. The primary efficiency gain will be the saving of time spent in tutorials, practical and fieldwork exercises and assessment; the CAL modules will also replace and complement some formal lecture material.

The project will also be sensitive to the fact that many students will not have an extensive background in geography, many will not initially be well disposed to IT, and that there are gender and other social issues which affect the learning environment. Many courseware modules will typically combine units that link theory with data-handling and other practical exercises to promote the understanding of a clearly-defined set of concepts. In addition to developing new materials, the project will endeavour to integrate existing resources produced under CTI phase I, many of which remain largely undeveloped or unfocused for current needs. Cooperative links have also been agreed and established with various TLTP phase I projects to ensure compatibility of standards and associated integration issues.

Because the project aims to involve virtually all the nation's geography departments, very high efficiency gains are achievable within a short time of the project's completion. First-year teaching — inclusive of lectures, practical classes and tutorials — in some 100 departments involves more than 65,000 hours of staff time annually. If only half of the departments adopt only half of the planned materials, a considerable 4,000 teaching hours could be saved. At a notional £35 per hour this represents £140,000: it is a significant annual return on the investment in the consortium and much higher returns are realistically achievable. Efficiency gains will be focused on several key areas: reduction of routine low-level tasks by production of self-directed learning

facilities; minimising repetitive teaching; development of more efficient evaluation procedures; development of student self-assessment procedures; enhanced access to on-line data-sets for teaching purposes; reduction of time spent on producing learning-support materials; more efficient systems for monitoring student progress; more efficient systems of course administration.

As the project has only just begun it is currently too early to assess a measure of success. Our centralised approach — panels of academics passing specifications to professional programmers — is, however, a considered response to the experiences of earlier projects. It was adjudged preferable to the alternative, distributed approach in which individual academics acquire sufficient authoring skills to undertake module production themselves.

Options for the Future

It seems clear that the most appropriate basis for ensuring the widespread implementation of IT-based approaches to teaching and learning in higher education in the UK involves a synergistic and complementary relationship between CTI and TLTP. Following a review of CTI performance in early 1994, the UK HEFCs have all agreed to continue funding the initiative until at least 1999, albeit with some redefinition of roles still to be completed. It is expected that CTI will continue to provide the infrastructure necessary for the successful dissemination of TLTP materials. The traditional focus on support for individual members of academic departments has already been extended by the large increase in subject constituencies following removal of the binary divide. Now CTI is being asked to establish closer links with institutional managements. With the continuing confidence of the HEFCs and the relative security of a prolonged period of funding, the use of CTI to promote IT in higher education is now founded on a far firmer footing than hitherto.

Conclusion

The events and issues described in this paper encompass a series of attempts to establish CBL as a mainstream activity within UK universities. Several of these attempts proved less successful than had initially been anticipated. However, many lessons have been learned throughout the process and it now seems that a successful strategy is now at hand. The key to the successful implementation of computer-based learning clearly entails the integration of hardware, software and "liveware" within a sound and supportive educational environment. This requires change within our institutions that is as much cultural as technological. It is too early to gauge the extent to which TLTP will succeed in achieving its aims. However, it is now accepted that CTI and TLTP are complementary, and indeed both now report to the same advisory group within the Funding Councils. The CTI experience has shown that for any CBL resource to be taken seriously enough to be incorporated into the curriculum it must offer the prospect of being useable for a sufficient length of time to justify the investment of effort involved in its production. It is also clear that effective production of courseware needs collaboration at as many levels as possible: individual, departmental, institutional, discipline, national and even international.

Note: Further information about CTI can be obtained from CTISS, University of Oxford Computing Centre, 13 Banbury Road, Oxford, OX2 6PN, UK. Fax: +44 865 273 275; Email: ctiss@vax.ox.ac.uk

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